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PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53 (b)(2).

Docket Number	12168-10USPR	Type a plus sign (+) inside this box→	+

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TITLE OF THE INVENTION *(280 characters max)*

RADIOACTIVELY COATED DEVICE AND METHOD OF MAKING SAME FOR PREVENTING RESTENOSIS

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ENCLOSED APPLICATION PARTS *(check all that apply)*

X	Specification	*Number of Pages* 20	X	Small Entity Statement	
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METHOD OF PAYMENT *(check one)*

	A check or money order is enclosed to cover the Provisional filing fees	PROVISIONAL FILING FEE AMOUNT ($)	$150.00
X	The Commissioner is hereby authorized to charge filing fees and credit Deposit Account Number: 19-5113		

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government

[X] No

[ ] Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE _____ Date: August 23, 1999

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REGISTRATION NO. *(if appropriate)* 37,037

[ ] Additional inventors are being named on separately numbered sheets attached hereto.

PROVISIONAL APPLICATION FILING ONLY

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Radioactively coated device and method of making same for preventing restenosis

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The invention relates to a radioactively coated device and to a method of making same by deposition of a radioisotope-containing molecule on the device.

(b) Description of Prior Art

Although coronary angioplasty procedure reduces anginal symptoms, a high incidence of restenosis (30 to 40% within 6 months) is the "Achilles' heel" of interventional cardiology. With over one million coronary procedures performed annually around the world, the economic effect of restenosis is substantial. It is estimated that an effective strategy to prevent restenosis, which would have to be applied after all coronary procedures, would represent a market of at least one billion U.S. dollars (US$) per year. To prevent occurrence of stenosis, new therapeutic strategies on the basis of ionizing radiation have recently been proposed. Intracoronary radiation therapy was reported to prevent intimal hyperplasia in various animal models (Carter et al., *Circulation*, 94(10):2364-2368, 1996; Wiederman et al., *J. Am. Coll. Cardiol.*, 25:1451-1456, 1995; Waksman et al., *Circulation*, 92(10):3025-3031, 1995; Verin et al., *Circulation*, 92(8):2284-2290, 1995). In clinical development, endovascular radiotherapy (wire- and stent-based) in patients was reported to be safe and effective in preventing restenosis post-angioplasty (Condado et al., *Circulation*, 90(3):727-732, 1997; Teirstein et al., *N. Engl. J. Med.*, 336(24):1697-1703, 1997; Verin et al., *Circulation*, 95(5):1138-1144, 1997; and King et al., *Circulation*, 97:2025-2030, 1998). To date, there is no consensus on the use of

beta- or gamma-sources to prevent restenosis. However, beta-emitter source (^{32}P, ^{90}Y, $^{90}Sr/Y$) significantly reduces operator exposure compared with previous trials with the gamma-emitter isotopes (^{192}Ir). Compared to brachytherapy approach, stent-based radiotherapy acts by preventing both vessel shrinkage and excessive neointimal proliferation.

One of the main limitations of the extensive use of radioactive stent in interventional cardiology is the complex clinical prescription of the metallic prosthesis (diameter, length, type, etc.) associated with the choice of the radioisotope and the activity in function of the physical half-life. Regarding those specifications, the production of an active inventory of such device in a daily practice can be difficult and problematic. A major difficulty to overcome is the need to load any pre-manufactured stents with defined amounts of radioactivity at the time of use. Using stents that are preloaded by the manufacturer is not ideal because the stent specifications (specific radioactivity, length diameter, etc.) may differ from the need.

Häfeli et al. (*Biomaterials* 19:925-933, 1998) suggested a method for electrodepositing Rhenium (^{186}Re or ^{188}Re) on a stent. However, Häfeli et al. teach that rhenium alone do not electroporate well by itself, and that they had to codeposit the rhenium with cobalt. Again codeposition with cobalt caused cracking and flaking of the deposited layer. To overcome these problems, Häfeli et al. deposited over the layer of cobalt rhenium previously deposited a second layer of gold to overlay cobalt and thus prevent cracking. Häfeli et al. also teach that gold, being a noble metal compete with rhenium during the

deposition such that gold is deposited preferentially over rhenium.

Consequently it would be highly desirable to be provided with a strong and rapid deposition process of radioactivity emitting source (such as ^{32}P-oligonucleotide based) on the surface of a device such as a stent to prevent restenosis post-angioplasty, and that would not crack or flake. The ability of ^{32}P-labeled oligonucleotide to inhibit neointimal hyperplasia was already demonstrated in an *in vitro* model (Fareh et al., *Circulation*, 99:1477-1484, 1999).

SUMMARY OF THE INVENTION

One aim of the present invention is to provide a strong and rapid deposition process of radioactive molecule on the surface of an angioplastic device for preventing restenosis post-angioplasty.

In accordance with the present invention there is provided a method for depositing a radioactive charged molecule on an angioplastic device, said method comprising the step of contacting the angioplastic device with a solution containing the radioactive charged molecule under suitable conditions for deposition of the radioactive charged molecule on the angioplastic device.

The deposition can be passive or active. By active deposition, it is meant to comprise electrodeposition.

In passive deposition, the angioplastic device has preferably gold on its surface, and the radioactive charged molecule preferably comprises a thiol-containing group for attaching to the gold on the angioplastic device.

Also in accordance with the present invention, there is provided a method for electrodepositing a

radioactive charged molecule on an angioplastic device. The method comprises the step of applying an electric potential difference between the angioplastic device and a solution containing the radioactive charged molecule, said charged molecule having a charge opposite to the electric potential difference and being thereby electrodeposited on the angioplastic device.

The electric potential difference can be made positive or negative, depending on the charge of the molecule to be coated on the device.

Preferably the radioactive molecule comprises a β-emitter. Preferred β-emitters are selected from the group consisting of Antimony-124, Cesium-134, Cesium-137, Calcium-45, Calcium-47, Cerium 141, Chlorine-36, Cobalt-60, Europium-152, Gold-198, Hafnium-181, Iodine-131, Iridium-192, Iron-59, Lutetium-177, Mercury-203, Neodymium-147, Nickel-63, Phosphorus-32, Phosphorus-33, Rhenium-186, Rubidium-86, Ruthenium-106, Samarium-153, Scandium-46, Silver-110m, Strontium-89, Strontium-90, Sulfur-35, Technetium-99, Terbium-160, Thulium-170, and Yttrium-90.

When the electric potential difference applied is positive, the radioactive molecule is preferably selected from the group consisting of a radioactive DNA or an analog thereof, a radioactive RNA, a radioactive nucleotide, a radioactive oligonucleotide, radioactive H_2PO_4, radioactive diethylenetriaminepenta-acetic acid, and a radioactive polyanionic complex. More preferably the radioactive molecule is a radioactive oligonucleotide. The oligonucleotide is preferably a 10- to 30-mer oligonucleotide, more preferably a 10- to 20-mer oligonucleotide, and most preferably a 15-mer oligonucleotide. These molecules

form negative ions in solutions and are therefore attracted onto the angioplastic device.

When the electric potential difference applied is negative, radioactive molecule is preferably selected from the group consisting of radioactive conjugated cationic polypeptides, radioactive cationic peptides, radioactive dextran, radioactive polyamines and radioactive chitosan. These molecules form positive ions in solutions and are therefore attracted onto the angioplastic device.

The angioplastic device may be for example a stent. Preferably the angioplastic device has a metallic surface, such as stainless steel, gold, tantalum, nickel and titanium or any alloy thereof.

The method of the present invention may further comprises before the step of applying an electric potential difference, a step of washing the angioplastic device with a solvent for removing impurities at the surface of said angioplastic device, or, after the step of applying an electric potential difference, a further step of rinsing the angioplastic device for removing free radioactive molecule at the surface of said angioplastic device.

Still in accordance with the present invention, there is provided an angioplastic device for preventing restenosis in a coronary and/or peripheral artery, said device comprising a radioactive charged molecule deposited on its surface.

Further in accordance with the present invention, there is provided a method for preventing restenosis in a coronary and/or peripheral artery comprising implanting an angioplastic device as defined above at a site of potential restenosis in a coronary and/or peripheral artery of a patient in need of such a treatment.

The method of the present invention is rapid and allows obtaining a radioactively coated device, on which a radioisotope-containing molecule is effectively and uniformly deposited. No adverse effects of deposition treatment are observed in coated stent *in vitro* (mechanical and colorless properties) and *in vivo* (clotting, thrombogenicity). Strong binding of ^{32}P-oligonucleotides on metallic surface was obtained.

Since the method of the present invention is rapid, it also allows to use simultaneously a stent with radiotherapy for preventing restenosis. It is now possible with the method of the present invention to attach a radioisotope-carrying molecule on a device such as a stent, according to a simple method. The simplicity of the method allows for that method to prepare a radioactively coated stent to be used for implantation just moments after its preparation.

By the term radioactively coated device, it is intended to mean any device used in the art for treating restenosis. Such device can be without limitation a stent or a radioactive filament for radiotherapy at the site of restenosis or at the site of angioplasty for preventing restenosis in coronary or peripheral vessels.

By the term angioplastic device, it is intended to mean any device used for angioplasty for which radiotherapy would be beneficial. Such device may be without limitation a stent or a wire or any other device to which a person of the art may think of for the prevention of an uncontrolled proliferative lesion. The term angioplastic device is also meant to include any prosthesis to be implanted within a vessel or within other body conduit such as, but not

restricted to, the bile duct or urethra for the purpose of endovascular treatment.

By the term analog of DNA, it is intended to mean nucleic acid sequences such as double-strand DNA sequences, single-strand DNA sequences, RNA or any combination thereof.

By the term radioactive polyanionic complex, it is intended to means a molecule carrying at least one radioactive element and bearing at least one negative charge.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred embodiment thereof, and wherein:

Fig. 1 illustrates a schematic electrodeposition set-up in accordance with a preferred embodiment of the present invention; and

Fig. 2 is a scan graph of two stent coated with the method of the present invention illustrating the distribution of the radioactive particles onto the metallic surface on the length of the device.

DETAILED DESCRIPTION OF THE INVENTION

In accordance with the present invention, there is provided a method for electrodepositing a radioactive molecule on a device for preventing restenosis.

In a preferred embodiment of the invention, the deposition is an electrodeposition as illustrated in Fig. 1 with the potentiostat 20. However, in another preferred embodiment of the invention, the deposition is a passive deposition in which case the set up is similar to the one illustrated in Fig. 1, with the

exception that no potentiostat 20 is needed. In such an embodiment, the alternate method of depositing a radioactive polyanionic complex, such as a radioactive oligonucleotide, comprises the step of modifying the oligonucleotide by adding a thiol-containing group. The thiol-containing group may be for example a C_6 chain carrying a thiol function at its extremity and which is added at the 5' end of the oligonucleotide. The so-modified oligonucleotide may be labeled with ^{32}P or other radioactive elements. A gold or gold-coated stent is incubated in 0.1M potassium phosphate buffer (KPO_4 pH 7.0) containing the radiolabeled oligonucleotide. After a 20-minute incubation period at room temperature, the stent is rinsed with distilled water. The radioactive oligonucleotide attaches to gold by the thiol group, producing a radioactively coated stent. This preferred embodiment is only an example of passive deposition caused by the high affinity of gold for thiol group.

In another embodiment of the invention, the radioisotope can be attached to other radioisotope-carrying molecule.

For instance, in a preferred embodiment of an electrodeposition set-up (Fig. 1) where the stent plays the role of the anode (positively charged), a negatively charged molecule can be used for an effective electrodeposition onto the stent surface. Preferred negatively charged molecules can be for example without limitation labeled DNA or RNA, or labeled analogs thereof, labeled nucleotides, radioactive H_3PO_4, labeled diethylene triamine pentaacetic acid (DTPA) or labeled polyanionic complexes.

In another preferred embodiment of an electrodeposition set-up where the stent plays the

role of the cathode (negatively charged), a positively charged molecule can be used for an effective electrodeposition onto the stent surface. Such positively charged molecule can be for example without limitation labeled conjugated polypeptides, labeled cationic peptides, labeled dextran, labeled chitosan or labeled polyamines.

In accordance with one embodiment of the invention, there is provided a process that can be performed in a daily practice moments prior to the implantation of the device in a cathlab or in the radiation oncology department, and administered to the patient according to the specification desired. The vehicle carrying the radioisotopic source such as a beta-source (^{32}P) is preferably a short DNA sequence (15 mer oligonucleotides linked together by 11 phosphorothioate bounds, rendering the molecule stable over a long time. Strong binding of DNA-oligonucleotides was reported on gold (Sellergren et al., *Anal. Chem.*, 68(2):402-407, 1996).

When double-stranded nucleic acid is used to be coated on the stent, a first non-radiolabeled strand of this double-stranded nucleic acid can be coated on the stent in accordance with one embodiment of the invention. The second complementary strand of the double-stranded nucleic acid can be labeled and annealed to the first strand. Such embodiment is also envisioned by the present invention, and is also encompassed in the term a radioactively coated device.

While a β-emitter source of radioisotope is preferred, other sources of radioisotope can also be used in accordance with the present invention.

The radioisotopic source is determined according to the treatment determined. Depending on the cases, the radiotherapy might vary from one

patient to another. Accordingly, the radioisotopic source will be determined based on the half-life of the radioisotopic source, its energy and the specific activity of the radioisotopic source desired. The determination of the radioisotopic source is within the skill of a person of the art.

The most preferred radioisotopic source are β-emitter source selected from the group consisting of Antimony-124, Cesium-134, Cesium-137, Calcium-45, Calcium-47, Cerium 141, Chlorine-36, Cobalt-60, Europium-152, Gold-198, Hafnium-181, Iodine-131, Iridium-192, Iron-59, Lutetium-177, Mercury-203, Neodymium-147, Nickel-63, Phosphorus-32, Phosphorus-33, Rhenium-186, Rubidium-86, Ruthenium-106, Samarium-153, Scandium-46, Silver-110m, Strontium-89, Strontium-90, Sulfur-35, Technetium-99, Terbium-160, Thulium-170, and Yttrium-90.

Stent characteristics and surface pre-treatment

In a preferred embodiment, an ACS multi-link RX DUET™ stents (Guidant Vascular Intervention, Santa Clara, CA) of 15 to 23 mm of length were used in accordance with the present invention.

Deposition or electrodeposition is more effective when the surface to be coated is pre-treated. To do so, stents to be coated were first washed with organic solvents (acetone or methanol) for removing contaminants and then air-dried.

^{32}P-oligonucleotide compounds

In one embodiment of the invention, the vehicle chosen for carrying the beta-source (^{32}P) is a short DNA sequence (15 mer oligonucleotides linked together by 11 phosphorothioate bounds, patent No. 5,821,354). This short DNA sequence was reported to be highly stable and effective in the prevention of cell

proliferation with no side effects (Fareh et al., *Circulation*, 99:1477-1484, 1999).

Electrodeposition of ^{32}P-oligonucleotides

In Fig. 1, electrodeposition is effected in an electrochemical bath 10 containing the ^{32}P-oligonucleotides (75 µCi/50 µL of water) diluted in 250 µL of acetate sodium buffer, ($CH_3CH_2CO_2Na.3H_2O$ at 0.2 M) at pH 8.5. In the electrochemical bath 10 containing both electrolyte and ^{32}P-oligonucleotide solutions 12, a metallic stent 14 was fixed to the anode 18 and the cathode 16 was composed of a platinum wire of 2 mm diameter and 5 cm length.

Electrodeposition is performed by applying a voltage of 1 Volt (50-60 mA) for 15 minutes using a standard potentiostat 20 at room temperature.

Electrodeposition succeeds in binding 2.5% of initial ^{32}P-oligonucleotides on the stent surface, when any post-treatments were applied.

Post-treatment of the radioactive stents (*in vitro* retention)

Following electrodeposition, radioactive stents were rinsed in distilled water for 24 hours at room temperature and air-dried or sonicated for 30 minutes. Biological treatments were investigated by incubating radioactive stents with DMEM supplemented with an enzyme solution consisting of 5 µl of Nuclease S_1 (332 U/µl), 1 µl of Exonuclease III (*E. coli*; 100 U/µl), and 1 µl of phosphodiesterase (0.5 U/µl) in presence of 10% Fetal Bovine Serum (FBS, Gibco) overnight at 37°C.

Following incubation of coated stents in water for 24 hours, 80% of initial coating solution remained on the metallic surface, whereas additional sonication procedure (30 minutes) reduced to 50% the retention rate. Following a biological treatment (blood

mimicking enzyme solution) of coated stents at 37°C during 14 to 16 hours, 12% of the amount of radioactivity remained on the stent, when compared to the initial electrodeposition rate.

Radioactivity distribution onto the surface

Coated stents were scanned for 4 hours to visualize the distribution of ^{32}P-oligonucleotides onto the metallic surface. The stent radiation uniformity was measured using a 0.5 mm slit in front of a Geiger counter which was moved over the stent in 0.5 mm steps by a computer controlled stepping motor.

Regarding the scan graph of the coated stent, the electrodeposition was relatively uniform on the metallic surface (see Fig. 2).

Mechanical properties of the radioactive coated stents

General observations were done on the coated stents such as determination of color and rigidity. Mechanical properties were estimated by mimicking *in vivo* stent deployment. After mounting the stent on deflated balloon, the balloon was inflated to 10-14 atm and the capability of stent deployment was evaluated. No physical alteration (color and deployment ability, surface deterioration, cracking and flaking of the surface) was observed in coated stents according to the present invention. Under fluoroscopy, the visibility of the coated stent was not modified.

Implantation of the radioactive coated stent in porcine coronary arteries

Domestic pigs were sedated with intramuscular injection of ketamin, azaperon and atropine to undergo anesthesia with thiopental sodium (iv). The pigs were intubated and ventilated with a mix of isoflurane 2% and oxygen during the procedure. An 8 Fr. guiding catheter was advanced through a femoral sheath with a

0.035 J guide-wire, under fluoroscopic monitoring in the ascending aorta. The guide wire was then removed, allowing the guiding catheter to be positioned in the ostium of the target vessel. Prior to performing the angiography, a bolus of 1 ml of nitroglycerin solution with a concentration of 0.3 mg/mL is injected intracoronary. The angiography was then performed in at least two near orthogonal views that visualize the target site of right coronary artery (RCA) or left circumflex artery (LCX) of the pig. A quantitative coronary angiography (QCA) measure was done to assess the vessel size for stent implantation. ACS stent was advanced to the target site and balloon inflation at 10 to 12 atm for 30 seconds was performed to adequately deploy the stent (2 stents per pig). Following stent implantation, the balloon was deflated and the catheter withdrawn. Control angiography was then performed to document any residual luminal stenosis or vessel wall dissection. If spasm was documented, 1 ml of nitroglycerin solution at a concentration of 0.3 mg/mL was injected intracoronary.

Macroscopical observations

After stent implantation, treated pigs were maintained for 6 hours under observation. Following pig euthanasia with a lethal dose of KCl, myocardium was dissected to remove stented arteries. A macroscopical observation of the heart and stented artery was performed to explore the potential side effects of coating stent implantation (thrombogenicity, clotting, etc.). Stents were then removed from the artery to be counted to assess the *in vivo* retention of ^{32}P-oligonucleotides onto the stent surface.

Following flucroscopy and macroscopical observations, no side effects related to the implantation of a radioactive treated stent according to the present invention were observed either in the myocardial tissue or in the implanted artery. Measurements of radioactivity level of coated stents revealed that 6 hours following stent implantation 45% of initial coated activity remained on the stent surface, whereas low radioactivity was detected in the target artery (less than 3%), suggesting that coronary wash-out eliminates more than 44% of the drug from the stent surface within 6 hours. The biological half-life of coated ^{32}P-oligonucleotides on the surface stent in porcine coronary arteries was estimated to be approximately 5.5 to 6 hours. The residence time of the coated ^{32}P-oligonucleotides is 11- to 12-fold higher than direct intra-mural administration of liquid ^{32}P-oligonucleotides using the Infiltrator® catheter (0.51 hours).

While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modifications and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice within the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as follows in the scope of the appended claims.

What is claimed is:

1. A method for depositing a radioactive charged molecule on an angioplastic device, said method comprising the step of contacting the angioplastic device with a solution containing the radioactive charged molecule under suitable conditions for deposition of the radioactive charged molecule on the angioplastic device.

2. The method of claim 1, wherein the deposition is a passive deposition.

3. The method of claim 2, wherein the angioplastic device has gold on its surface, and wherein the radioactive charged molecule comprises a thiol-containing group for attaching to the gold on the angioplastic device.

4. The method of claim 1, wherein the deposition is an electrodeposition.

5. A method for electrodepositing a radioactive charged molecule on an angioplastic device, said method comprising the step of applying an electric potential difference between said angioplastic device and a solution containing the radioactive charged molecule, said charged molecule having a charge opposite to the electric potential difference and being thereby electrodeposited on the angioplastic device.

6. The method of claim 5, wherein the electric potential difference is positive.

7. The method of claim 5, wherein the radioactive molecule comprises a β-emitter.

8. The method of claim 7, wherein the β-emitter is selected from the group consisting of Antimony-124, Cesium-134, Cesium-137, Calcium-45, Calcium-47, Cerium 141, Chlorine-36, Cobalt-60, Europium-152, Gold-198, Hafnium-181, Iodine-131, Iridium-192, Iron-59, Lutetium-177, Mercury-203, Neodymium-147, Nickel-63, Phosphorus-32, Phosphorus-33, Rhenium-186, Rubidium-86, Ruthenium-106, Samarium-153, Scandium-46, Silver-110m, Strontium-89, Strontium-90, Sulfur-35, Technetium-99, Terbium-160, Thulium-170, and Yttrium-90.

9. The method of claim 6, wherein the radioactive molecule is selected from the group consisting of a radioactive DNA or an analog thereof, a radioactive RNA, a radioactive nucleotide, a radioactive oligonucleotide, radioactive H_2PO_4, radioactive diethylenetriaminepentaacetic acid, and a radioactive polyanionic complex.

10. The method of claim 9, wherein the radioactive molecule is a radioactive oligonucleotide.

11. The method of claim 10, wherein the oligonucleotide is a 10- to 30-mer oligonucleotide.

12. The method of claim 10, wherein the oligonucleotide is a 10- to 20-mer oligonucleotide.

13. The method of claim 10, wherein the oligonucleotide is a 15-mer oligonucleotide.

14. The method of claim 5, wherein the electric potential difference is negative.

15. The method of claim 14, wherein the radioactive molecule is selected from the group consisting of radioactive conjugated polypeptides, radioactive cationic peptides, radioactive dextran, radioactive polyamines and radioactive chitosan.

16. The method of claim 5, wherein the angioplastic device is a stent.

17. The method of claim 16, wherein the angioplastic device has a metallic surface.

18. The method of claim 17, wherein the metallic surface is selected from the group consisting of stainless steel, gold, tantalum, nickel and titanium or any alloy thereof.

19. The method of claim 5, further comprising before the step of applying an electric potential difference, a step of washing the angioplastic device with a solvent for removing impurities at the surface of said angioplastic device.

20. The method of claim 5, further comprising after the step of applying an electric potential difference, a step of rinsing the angioplastic device for removing free radioactive molecule at the surface of said angioplastic device.

21. An angioplastic device for preventing restenosis in a coronary and/or peripheral artery,

said device comprising a radioactive charged molecule deposited on its surface.

22. The angioplastic device of claim 21, wherein the radioactive molecule comprises a β-emitter.

23. The angioplastic device of claim 21, wherein the β-emitter is selected from the group consisting of Antimony-124, Cesium-134, Cesium-137, Calcium-45, Calcium-47, Cerium 141, Chlorine-36, Cobalt-60, Europium-152, Gold-198, Hafnium-181, Iodine-131, Iridium-192, Iron-59, Lutetium-177, Mercury-203, Neodymium-147, Nickel-63, Phosphorus-32, Phosphorus-33, Rhenium-186, Rubidium-86, Ruthenium-106, Samarium-153, Scandium-46, Silver-110m, Strontium-89, Strontium-90, Sulfur-35, Technetium-99, Terbium-160, Thulium-170, and Yttrium-90.

24. The angioplastic device of claim 21, wherein the radioactive molecule is selected from the group consisting of a radioactive DNA or an analog thereof, a radioactive RNA, a radioactive nucleotide, a radioactive oligonucleotide, radioactive H_2PO_4, radioactive diethylenetriaminepentaacetic acid, and a radioactive polyanionic complex.

25. The angioplastic device of claim 21, wherein the radioactive molecule is a radioactive oligonucleotide.

26. The angioplastic device of claim 21, wherein the oligonucleotide is a 10- to 30-mer oligonucleotide.

27. The angioplastic device of claim 21, wherein the oligonucleotide is a 10- to 20-mer oligonucleotide.

28. The angioplastic device of claim 21, wherein the oligonucleotide is a 15-mer oligonucleotide.

29. The angioplastic device of claim 21, wherein the radioactive molecule is selected from the group consisting of radioactive conjugated polypeptides, radioactive cationic peptides, radioactive dextran, radioactive polyamines and radioactive chitosan.

30. The angioplastic device of claim 21, wherein the angioplastic device is a stent or a microcatheter wire.

31. A method for preventing restenosis in a coronary and/or peripheral artery comprising implanting an angioplastic device as defined in claim 19 at a site of potential restenosis in a coronary and/or peripheral artery of a patient in need of such a treatment.

ABSTRACT OF THE INVENTION

The present invention relates to a rapid and reproducible electrochemical method leading to the production of radioactive angioplastic device such as stents, based on rapid and effective deposition or electrodeposition of charged radioactively coated molecule on oppositely charged surfaces (stainless or gold).

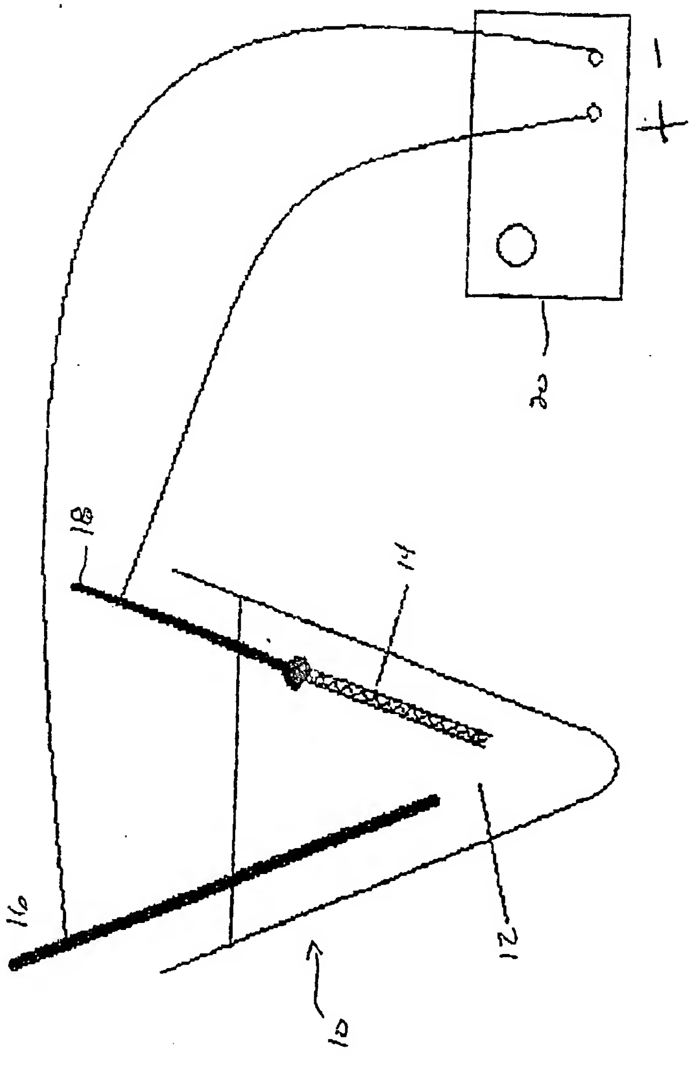

Fig. 1

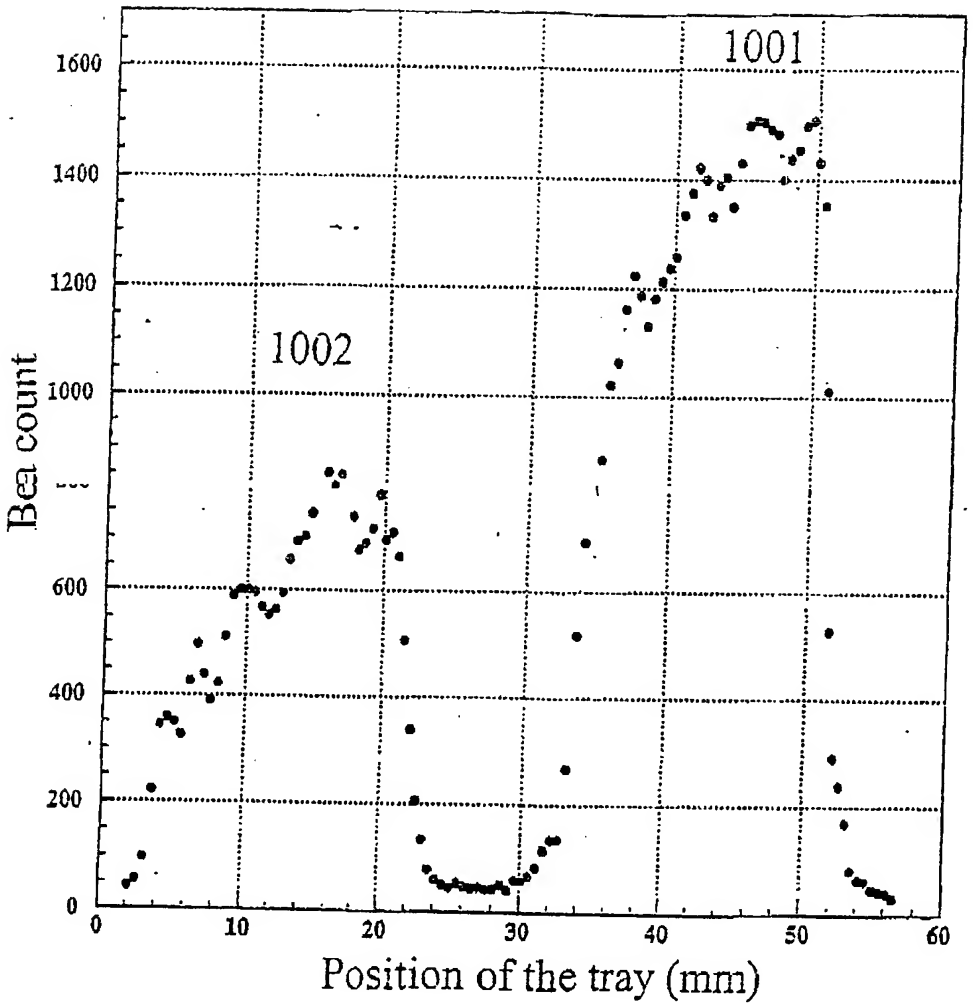
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Fig. 2